ST. LOUIS PUBLIC LIBRARY

TRANSACTIONS

OF THE

ILLUMINATING ENGINEERING SOCIETY

FOUNDED IN LONDON 1909 INCORPORATED 1930

CONTENTS

	Page
Election of Officers and Council - - -	18
Notes on Recent Meetings and Events - -	19
Forthcoming Events - - - - - -	20
Incandescence Gas Lighting, by Dean Chandler - - - - - - - -	21

VOLUME III—No. 2
FEBRUARY 1938

32 VICTORIA STREET
LONDON SW1

ELECTION OF OFFICERS AND COUNCIL

SESSION 1938-1939. OFFICIAL NOTICE

IN accordance with the procedure specified in the Articles of the Society, a list of existing Officers and Members of Council, of vacancies occurring and of duly qualified persons nominated by the Council for vacancies about to occur in the offices of President, Vice-Presidents, Hon. Treasurer, Hon. Secretary, and Ordinary Members of Council is presented below for the information of the Members of the Society.

In the event of any Members desiring to put forward other names, the Council will be pleased to receive such nominations, which should be made in accordance with the following rule (Article 48) :—

> "After the issue of the Council's list, and not later than the 15*th day of April* next following, any ten Members (but no more than ten) may nominate any other duly qualified person to fill any such vacancy by delivering such nominations in writing to the Hon. Secretary, together with the written consent of such person to accept office if elected, but each such nominator shall be debarred from nominating any other person for the same office at such election."

Present Officers and Members of Council

President :—*S. English, D.Sc., F.I.C., F.Inst.P.*

Past Presidents :—

Mr. A. P. TROTTER, M.INST.C.E.
Sir JOHN HERBERT PARSONS, C.B.E., F.R.S.
Mr. D. R. WILSON, C.B.E.
Dr. C. C. PATERSON, O.B.E., M.INST.C.E., M.I.E.E.
Dr. J. W. T. WALSH, M.A., M.I.E.E.
Lt.-Col. K. EDGCUMBE, T.D., M.INST.C.E., M.I.E.E.
Sir FRANCIS GOODENOUGH, C.B.E.
Lt.-Com. HAYDN T. HARRISON, M.I.E.E., R.N.V.R.
Mr. C. W. SULLY.
Mr. H. HEPWORTH THOMPSON.
Mr. A. W. BEUTTELL, M.I.E.E.
Mr. A. CUNNINGTON, B.SC., M.I.E.E.

Vice-Presidents :—

Mr. Percy Good (1936)
Mr. F. C. SMITH (1937)
Mr. W. J. JONES (1937)

Members of Council :—

Mr. R. O. ACKERLEY (1936)
Mr. A. M. Bell (1937)
Mr. B. F. W. BESEMER (1937)
Mr. H. BRIGHT (1937)
Mr. D. Chandler (1935)
Mr. J. F. COLQUHOUN (1937)
Col. C. H. Silvester Evans (1937)
Dr. W. M. Hampton (1935)
Mr. H. Lingard (1935)
Mr. HOWARD LONG (1936)
Dr. R. J. LYTHGOE (1936)
Mr. A. R. McGIBBON (1936)
Prof. J. T. MACGREGOR-MORRIS (1936)
Mr. C. A. Masterman (1937)
Mr. E. W. MURRAY (1936)
Mr. J. S. PRESTON (1937)
Mr. F. W. Purse (1935)
Mr. W. R. Rawlings (1935)
Mr. L. M. TYE (1937)
Mr. J. M. WALDRAM (1936)
Mr. H. C. WESTON (1936)
Mr. G. H. WILSON (1937)

Hon. Secretary :—*Mr. J. Stewart Dow* (1928)

Hon. Treasurer :—*Mr. E. Stroud* (1936)

Nominated by the Council to fill Vacancies

President :—Mr. PERCY GOOD, M.I.E.E.

Vice-President :—

Col. C. H. SILVESTER EVANS, O.B.E., T.D., M.I.E.E.

Members of Council :—

Mr. T. C. ANGUS

Mr. H. BUCKLEY

Mr. W. N. C. CLINCH

Mr. L. J. DAVIES

Mr. J. R. HEPPLE

Mr. A. V. HORSFALL

Major P. A. SMITH

Hon. Secretary :—Mr. J. S. DOW

Hon. Treasurer :—Mr. E. STROUD

The names in italics are those of retiring Officers or Members. The date in parentheses after each name indicates the date of election to Office or Membership of the Council.

NOTES ON RECENT MEETINGS AND EVENTS

General Meetings in London.

DECORATIVE MATERIALS AND THEIR RESPONSE TO LIGHT.

A meeting of the Society was held in the Lecture Theatre of the E.L.M.A. Lighting Service Bureau (2, Savoy-hill, London, W.C.2) on Tuesday, January 11, 1938. In the absence of the President (Dr. S. English) Mr. Percy Good presided.

The minutes of the last meeting having been taken as read, the President then called upon Mr. R. O. Ackerley to present his paper, entitled "Decorative Materials and their Response to Light," which was illustrated by lantern slides and demonstrations. On the motion of Mr. Good a vote of thanks was accorded to the author for his paper, and an interesting discussion ensued in which the following took part: Mr. A. W. Beuttell, Mr. F. P. Bentham, Mr. C. O. Masters, Mr. W. G. Raffé, Mr. J. S. Dow, Mr. J. C. Christopher, Mr. G. H. Wilson, and Mr. J. Preston.

A vote of thanks to the E.L.M.A. Lighting Bureau for their hospitality terminated the proceedings.

THE FINAL REPORT OF THE MINISTRY OF TRANSPORT COMMITTEE ON STREET LIGHTING.

A meeting of the Society was held in the Lecture Theatre of the Institution of Mechanical Engineers (Storey's Gate, St. James's Park, London, S.W.1) on Tuesday, February 8. The chair was taken by the President (Dr. S. English).

The minutes of the last meeting were taken as read. The President then called upon Dr. J. W. T. Walsh to deliver his address on the final report of the Ministry of Transport Committee on Street Lighting. On the motion of the President a vote of thanks was accorded to the author for his paper, and an interesting discussion ensued in which the following took part: Mr. E. J. Stewart, Mr. F. C. Smith, Mr. C. R. Bicknell, Mr. T. N. Riley, Mr. S. J. Patmore, Mr. G. H. Wilson, Mr. E. S. Perrin, Mr. J. R. Hepple, Dr. C. C. Paterson, Mr. E. Stroud, and Mr. J. S. Dow.

After Dr. Walsh had briefly replied to the discussion, Mr. Dunbar gave a brief explanation of a film prepared at the National Physical Laboratory for the purpose of testing visibility in the streets. The film enabled an image in which the actual conditions of brightness in the street were reproduced to be maintained. Various objects were caused to appear and disappear at intervals, in order to ascertain whether there was any difference in the ease with which such objects could be detected by light of various colours.

At both the above meetings lists of elections pending and new applicants for membership (see p. 20) were exhibited for inspection by members present.

Sectional Meetings.

Photometry Section.

On January 18 members paid a visit to the Paint Research Station, Teddington. At the conclusion of the tour of the laboratories a welcome was expressed by Dr. Jordan (Director of the Station), after which a paper was read by Mr. R. F. Hanstock on "The Application of Photometric Methods in the Testing of Paint and Allied Products." The discussion was opened by Mr. Harold Bright and continued by Mr. J. C. Cooper, Mr. R. R. Holman, Dr. J. W. T. Walsh, and Mr. G. T. Winch. The latter, as Chairman of the Section, proposed a vote of thanks to Dr. Jordan and his staff.

Industrial and Public Lighting Section.

A joint meeting of these two sections took place at the E.L.M.A. Lighting Service Bureau on January 28, when a paper on "Railway Lighting" was read by Mr. M. G. Bennett. A discussion took place, in which Mr. J. Bateman, Mr. C. A. Morton, Mr. P. S. Barton, Mr. J. S. Preston, Mr. A. R. McGibbon, Mr. F. C. Smith, Mr. J. S. Dow, and Mr. G. W. Golds took part. After Mr. Bennett had briefly replied to the discussion, a vote of thanks to the author and the E.L.M.A. Lighting Service Bureau for their hospitality was proposed by Mr. A. Cunnington, who presided.

Decorative Lighting Section.

On January 27 members paid a visit to the premises of D. H. Evans, Ltd., where they were welcomed by Mr. R. D. Barrell, the store manager. Major P. A. Smith, who had prepared a printed description of the lighting arrangements, made a few remarks drawing attention to special features, and the party, after an expression of thanks to the management had been conveyed by the honorary secretary, made a complete tour of the building.

Meetings of Local Centres.

North Midland Local Centre.

On January 17 a visit to the works of Messrs. Montague Burton, Ltd., was followed by a paper by Mr. J. W. Howell on "Lighting in the Textile Industry."

North-Western Local Centre.

On January 27 a paper was read by Mr. A. Edgar, who reviewed a variety of problems involved in lighting for entertainment and sport (including boxing and wrestling, circus lighting, spectacles on ice, speedway lighting, etc.).

Irish Free State.

On January 5 an address on "The Sodium Vapour Electric Discharge Lamp; its Development and Applications," was delivered by Professor G. B. van der Werfhorst, and was followed by a discussion in which Mr. N. A. Chance, Mr. J. O'Farrel, and Mr. G. Houlihan took part. A vote of thanks to the author was proposed by Mr. Chance. Mr. F. X. Algar presided.

Forthcoming Events

LONDON.

March 1st. Mr. F. C. SMITH on **Illumination Levels and Comfort Conditions** as applied to the Lighting, Heating, and Ventilating Problem (Joint Meeting with the Institution of Heating and Ventilating Engineers), *(Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1)*; **6.30 p.m.**

March 4th. Discussion reviewing **Technical Aspects of the Final Report of the Ministry of Transport Committee on Street Lighting,** to be opened by Mr. G. S. LUCAS and Mr. A. R. MCGIBBON (Public Lighting Section of the Illuminating Engineering Society), *(Watson House, Townmead Road, Fulham, S.W.6)*; **6.30 p.m.**

March 15th. Annual Dinner at the Trocadero Restaurant, Piccadilly, W.1.; **6.45** for **7.30 p.m.**

March 22nd. MISS EDNA MOSELEY on **How I Would Plan the Lighting of a Home** (Decorative Lighting Section of the Illuminating Engineering Society), *(Gas Industry House, 1, Grosvenor Place, London, S.W.1)*; **6.30 p.m.**

March 29th. A Discussion on **The New Factory Act** in relation to Industrial Lighting (Industrial Lighting Section of Illuminating Engineering Society), *(Home Office Industrial Museum, Horseferry Road, London, S.W.1)*; **6.30 p.m.**

MANCHESTER.

March 28th. Mr. J. W. HOWELL on **Colliery Lighting** (North-Western Area Local Centre of the Illuminating Engineering Society), *(Engineers' Club, Albert Square, Manchester)*; **7.15 p.m.**

LEEDS.

March 21st. Annual Meeting and **Dinner** at the Gt. Northern Station Hotel, Leeds; **7.30** for **8 p.m.**

GLASGOW.

March 2nd. Mr. H. E. DE WEERDT on **Automatic Control of Illumination** (Scottish Local Centre of the Illuminating Engineering Society), *("The Gordon," 19, Gordon Street, Glasgow)*; **7.30 p.m.**

DUBLIN.

March 1st. Mr. R. GILLESPIE WILLIAMS on **Modern Colour Lighting for Cinemas and Theatres** (I.F.S. Local Centre of the Illuminating Engineering Society), *(Engineers' Hall, 35, Dawson Street, Dublin)*; **8 p.m.**

Applications for Membership.

Elections Completed.

At the general meeting of the Society held on January 11, 1938, the names of the following applicants for membership were presented, and these gentlemen were formally declared members at the subsequent meeting on February 8:—

CORPORATE MEMBERS:—

Ellis, Samuel I. .....North Eastern Electric Supply Co., Ltd., Carliol House, NEWCASTLE-UPON-TYNE 1.

Misselbrook, C. J. ...8, Glensdale Road, Brockley, LONDON, S.E.4.

Munns, J. H. .....44, Kings Road, Tottenham, LONDON, N.17.

Richards, A. C. .....Maddock Lake, Brassington, Wirksworth, DERBYSHIRE.

ASSOCIATE:—

Weitzel, S. L. .....8, Bonsfield Road, New Cross, LONDON, S.E.14.

COUNTRY MEMBER:—

Mitchell, Robert .....4, Oliver Place, Hawick, ROXBURGHSHIRE.

At the meeting on January 11 the names of those announced on December 14, which were published in the issue of the *Transactions* (Vol. III., No. 1, January, 1938, p. 2) were presented again, and these applicants were formally declared members of the Society.

Elections Pending.

At the general meeting of the Society held on February 8, 1938, the names of the following applicants for membership were presented:—

SUSTAINING MEMBERS:—

South Metropolitan Gas Company .....709, Old Kent Road, LONDON, S.E.15.
Representative:—Mr. Dean Chandler.

Hull Corporation Electricity Department .....Ferensway, HULL.
Representative:—Mr. J. N. Waite.

CORPORATE MEMBERS:—

Clarke, G. E. F. .....178, Hoppers Road, Winchmore Hill, LONDON, N.21.

Davis, J. W. .....53, Westlands, NEWCASTLE-UPON-TYNE.

Durrant, D. W. .....29, Steventon Road, LONDON, W.12.

Everett, G. J. .....108, Fletching Road, Clapton, LONDON, E.5.

Imrie-Smith, W. .....9, First Avenue, WESTCLIFF-ON-SEA.

Newell, W. F. .....Weston Electrical Instrument Company, Cambridge Road, Enfield, MDDX.

Reynolds, F. .....17-19, York Place, LEEDS 1.

COUNTRY MEMBERS:—

Mahmoud, M. A. .....Electrical Section, State Building Department, CAIRO.

Pettersen, J. F. .....c/o Newton McLaren, Ltd., Leigh Street, Adelaide, SOUTH AUSTRALIA.

Williams, J. R. .....89, Forest Road, NOTTINGHAM.

Wilson, W. N. .....13, Atha Street, Dewsbury Road, LEEDS.

ASSOCIATES:—

Blakeley, N. .....14, King Alfred's Drive, Meandwood, LEEDS 6.

France, R. W. .....142, Greenvale Road, ELTHAM, S.E.9.

INCANDESCENCE GAS LIGHTING

by DEAN CHANDLER *(Member)*

(Paper read on Tuesday, December 14, 1937)

Light Essentially Thermal in Origin.

Light from artificial sources is indispensable to the community. The hours from sunset to 11 p.m. amount to 1,680 in a year, and are approximately one-quarter of the usual hours of wakefulness, hence the need for sufficient and reliable sources of light.

Artificial light is produced by heating solids to temperatures at which they become incandescent, the higher the temperature the more intense the effect. Light from the self-luminous gas flame is the effect of heat upon the minute particles of nascent carbon which are liberated in the flame. Newton in the seventeenth century made one of his brilliant guesses when he called a flame " white, hot smoke."

Light from the glowing particles of carbon within the envelope of the self-luminous flame has as much right to the term " incandescence " as the Welsbach refractory hood. The light from the Welsbach gas mantle is the effect of flame upon the skeletonised fabric.

Light from carbon arcs and from gas-filled electric lamps is due to carbon in the one case, and in the other the metal filament being heated to incandescence by electrical energy. Light from the mercury vapour and similar lamps, although the result of electrical excitation may from one point of view be said to be also thermal in origin. One has only to trace back to the hydro or thermal generation of electricity to realise that fundamentally such is the case.

Light, then, is the effect of heat. When the source of the heat is flame, gaseous products result. These in themselves are harmless. Their presence in small quantities in the air is essential to life. Dr. Sherwood Taylor in his " World of Science " writes of carbon dioxide as follows: " It is a kindly and beneficent substance. It feeds the green plants of the world and it is harmless to man unless a great deal is breathed." It is a stimulant to breathing. The necessity for the presence of water vapour in the air is, of course, well known to most people.

Composition of Mantles.

This paper will deal only with lamps which depend upon flame for their light. I may remind you that soon after Welsbach discovered the valuable light-giving properties of the rare earth oxides he found that of them all the oxide thoria appeared to be the most satisfactory. He also observed that the more the thoria was purified the less was the light obtained from it. It was discovered later that a trace of ceria increased to a remarkable degree the emission of light. The use of a mixture of 99 per cent. thoria and 1 per cent. ceria has not been improved upon as regards efficiency of light emission. The reason for the effect of the small proportion of ceria is not fully understood. Catalysis has been suggested, but the phenomenon is still without complete explanation. Joblin has pointed out that with the Nernst electric lamp a similar effect is to be observed, for the pure zirconia rod which is heated by an electric current to a temperature at which it emits light is not so brilliant as when a trace of thoria or ceria is present. * It is known that the distribution of energy as well as the quantity in the radiation from an incandescent mantle depends on the proportion of ceria present. With a proportion of between 0.2 and 0.5 per cent. the visible spectrum emitted closely approaches that of daylight, but there is still a slight deficiency of blue. By using a blue reflector with the mantle a light is obtained which has a spectral luminosity almost identical with that of mean sunlight. Comparative curves of these are shown in Fig. 1.

Mention may be made in passing of mantles which

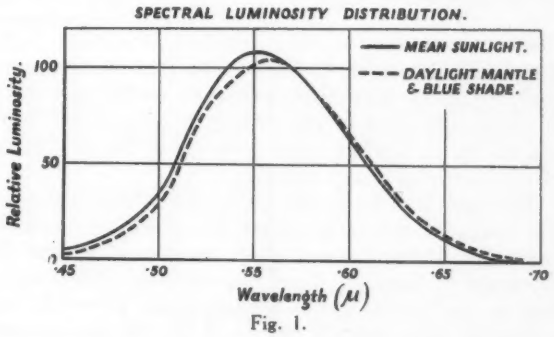

Fig. 1.

emit radiations rich in red, particularly suitable to improve the appearance of meat.

Design of Burners.

The advent of the incandescence mantle necessitated a complete change in the method of burning gas.

The self-luminous flame which had served the community for more than half a century had to give place to a flame of quite different character. A non-luminous flame is essential to develop light from the Welsbach mantle. Most people are familiar with the Bunsen burner, a device which depends upon efficient entrainment of air by the gas jet issuing from a fine hole or holes in what is called the ejector in the base of the mixing tube. It is to be noted that a great deal depends upon the design and construction of burners for the efficient utilisation of the gas to produce light. The first Bunsen gas burner made for use with the Welsbach mantle was a simple and

* A. R. Pearson. " Light and Lighting." July, 1937. pp. 192-194.

Fig. 2.

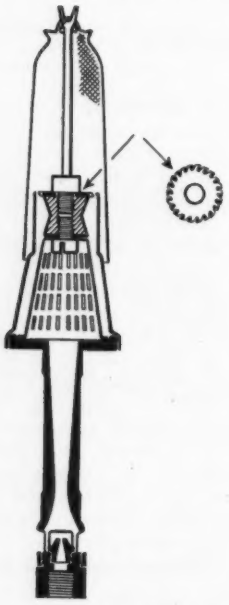

Fig. 3. Kern Burner.

not very efficient contrivance (see Fig. 2), and it was soon realised that improvements were possible to conserve the heat of the flame, to effect better mixing of the air and gas and to increase the proportion of air in the primary mixture.

The position of the gas jet in the mixing tube and the shape of the latter were found to influence the character of the flame and its temperature, and the intensity of the light from the mantle. The adaptation to the burner of the Venturi-tube principle had a marked effect on the nature of the air-gas mixture and the stability of the flame. Research to establish the principles of correct design had far-reaching results. Bandsept, Denayrouse, De Mare, and others, contributed much to our knowledge, but it was Otto Kern, of Paris, who produced a burner that gave a much higher luminous efficiency than any previous burner. A diagram of the Kern burner is shown in Fig. 3. Lord Moulton said that "Kern taught the world how to make a very efficient gas burner which did not require the use of a chimney or a gauze." Before Kern's invention a metal gauze had generally been used on the Davy lamp principle to prevent "backfire," but its use was not satisfactory. The gauze acted as an efficient dust filter which soon clogged with the dust particles from the air.

In the days of upright incandescence burners the ordinary gas pressure available (2 to 4 inches water column) was used. Later it was found that an increase in the light from the mantle was possible by using a higher gas pressure. Means were therefore adopted to augment the pressure of the gas. The greater efficiency obtained was due to the greater proportion of air entrained in the primary mixture. The flame was smaller and therefore hotter and the light emission much greater.

Temperature of Luminous and Aerated Flames.

It is a firmly established principle that the same amount of combustible material completely burnt gives out an unalterable quantity of heat whether the combustion takes place in a second or one hour. But so far as temperature is concerned, the matter is quite different—the temperature attained during combustion depends not only on the total quantity of heat but on the manner in which, so to speak, the heat is developed in a short space of time, or in a small volume. Take an ordinary Bunsen flame and close the air ports, and compare the volume or size of the luminous flame produced by the same amount of gas when the air ports are open to give a keen violet flame. In the one case the heat is distributed over a comparatively large space, in the other case the volume of flame is very much smaller and its temperature must therefore be higher.

The question has often been asked—is a Bunsen flame hotter than a self-luminous flame, consuming the same amount of gas? Vague ideas appear to prevail on this subject. The answer often obtained to a question on the point is that the Bunsen flame is hotter. If asked why, the answer is given "because the gas is more completely combusted." This, of course, is a fallacy. Neither the Bunsen flame burning freely in air nor a flame of a properly constructed burner giving a luminous flame yields products of imperfect combustion. Which is the hotter, the self-luminous or the Bunsen flame, depends entirely upon how the gas is burnt. It is possible to melt platinum wire (1755° C.) in the outer portion of a luminous flame.

Design of Inverted Burners.

About the beginning of the present century attention was directed to the fact that most of the light from the upright incandescent mantle was above the level of the burner, the illumination of the room below the burner being in a measure dependent upon the reflection of the light from the walls and ceilings of the room. If they were clean and light in colour the effect was satisfactory, and the light, of course, could be redirected by suitable reflectors disposed above the source. The solution of the problem appeared to be to invert the mantle. With adequate gas pressure, it was found, a well-designed Bunsen burner would satisfactorily function with its mouth directed downwards. The major part of the light was then directed below the horizontal, and was unobstructed by the parts of the burner and the fitting to which it was connected.

The first inverted gas burners were designed on principles inspired by very opposite ideas. Bernt and Cervenka, of Prague, working on the principle that it was essential to keep the mixing tube of the burner cool, made a burner with a porcelain jacket, which surrounded the metal mixing-tube to insulate it from the effect of the hot products of combustion. Hermann Ahrendt, of Berlin, proceeding on the principle that the air-gas mixture should be heated by the hot gases, constructed his burner with that in

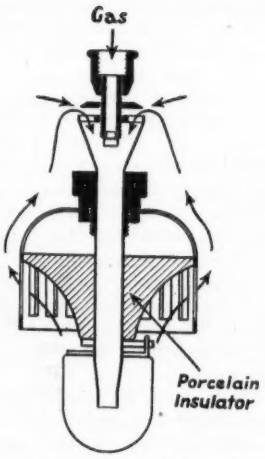

Fig. 4. Bernt and Cervenka Burner.
(Note the passage of the products of combustion.)

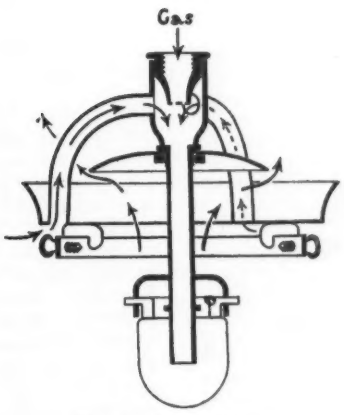

Fig. 5. Ahrendt Burner.

Fig. 6. Modified Bernt and Cervenka Burner.

view. Ahrendt realised also that it was essential to prevent the entrainment of any of the products of combustion through the primary airports of the burner. This had been overlooked by Bernt and Cervenka, who, later discovering the importance of this, modified their burner, providing it with a deflecting hood to divert the products of combustion from the primary airports. Burners due to these inventors are shown diagrammatically in Figs. 4, 5, and 6.

With the inverted gas mantle it became possible to apply the principle of recuperation to gas lamps in the simplest possible manner. The provision at the lower end of the burner mixing-tube of a suitable metal heat interchanger (preheater), clearly seen in Fig. 7, through which the mixture of air and gas must pass before issuing from the burner, was all that was required to effect a considerable degree of recuperation.

The recuperation principle is most adequately used in high pressure gas lamps (Fig. 8), which are used extensively not only for public lighting but also for factories and workshops. The high pressure system of lighting with its distinctive features has

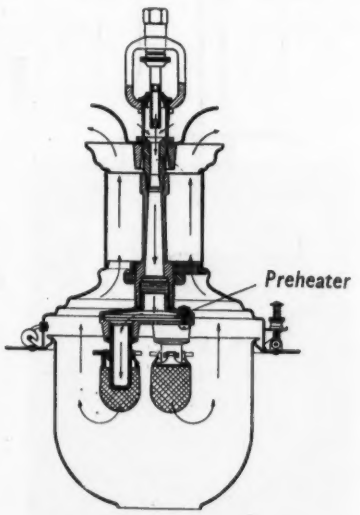

Fig. 7.

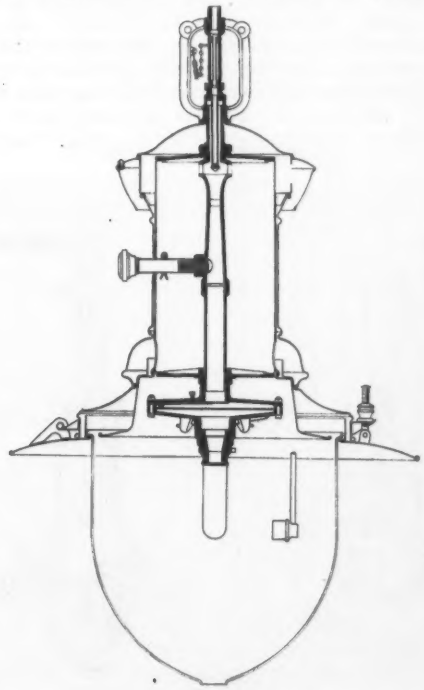

Fig. 8.

recently been referred to in detail in papers contributed to the Association of Public Lighting Engineers in September of this year.

It will, therefore, suffice here to state that the greater emission of light from a high pressure inverted gas lamp depends upon increasing the velocity of the jet of gas to entrain the full amount of air required for the complete combustion of the gas and to enable the whole of the products of combustion to be forced through the meshes of the mantle. With the low pressure system of gas lighting only a portion of the air requisite for complete combustion—about one half—is entrained by the jet of gas; the remaining air required to complete the combustion is supplied from the surrounding air.

A New High Power Low-Pressure Lamp.

Mr. George Keith has recently stated: "It may not appear that the passage of the whole of the products of the combustion of the gas through the meshes of the inverted mantle is of much consequence. It is, however, of the greatest importance, since the amount of light so produced from a given volume of gas is very much greater." With the low pressure system of lighting it has hitherto been considered practically impossible to obtain a mixture of gas and air sufficiently rich in oxygen to burn completely within the mantle, the kinetic energy of the air-gas stream not being sufficient to force all the products of combustion through the meshes of the mantle. It must also be noted that with an air and gas mixture in correct proportion for its complete combustion the velocity of flow of the mixture through the burner system must be greater than the speed of propagation of flame through such a mixture, otherwise firing-back will take place. In the case of the usual low pressure system the velocity of flow for a fully aerated mixture of gas and air is below this critical point. In addition to a fully aerated mixture the high pressure system permits of a high degree of preheating the full mixture of gas and air by a heat interchanger attached to the end of the mixing tube. This results in an increase in the efficiency of light production of about 100 per cent.

It is appropriate here to refer to the inverted high power gas lamp recently described by Mr. George Keith at the Conference of Public Lighting Engineers. Mr. Keith explained the application of a principle applied to low pressure gas lamps which enables a much higher efficiency to be obtained with low pressure gas than hitherto possible. An increase is obtained of about 50 per cent. above the best low pressure practice in operation to-day. Details of the design and construction of the new lamp were given at the September meeting of the Institution of Public Lighting Engineers at Folkestone. Fig. 9 shows photographs of the new lamp.

The essential features of the new Keith lamp consist of the use of syphon tubes through which the secondary air for the combustion of the gas is pushed under very small pressure through the meshes of the mantle with the result that complete combustion of the gas takes place within the fabric as in the case of the high pressure system.

High Pressure Lamps.

In connection with gas lighting by high pressure gas lamps it may be noted that while the usual form of gas mantle, cylindrical in shape, is eminently suited for general diffusion of light for street lighting, there seemed to be no fundamental reason why the shape of the mantle should not be altered

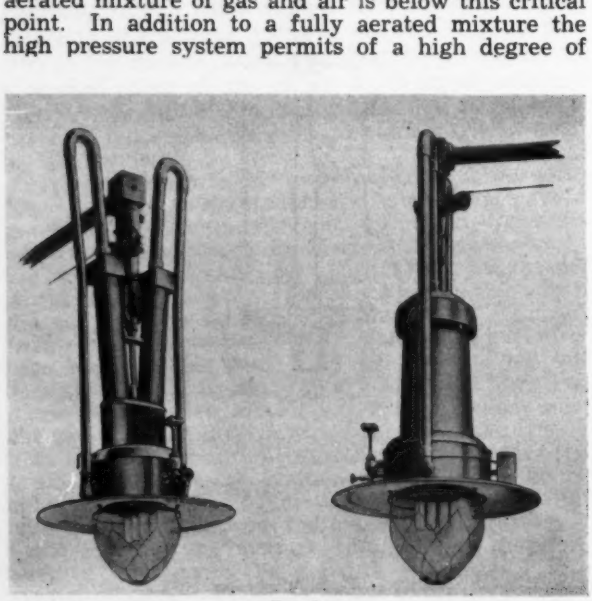

Fig. 9.

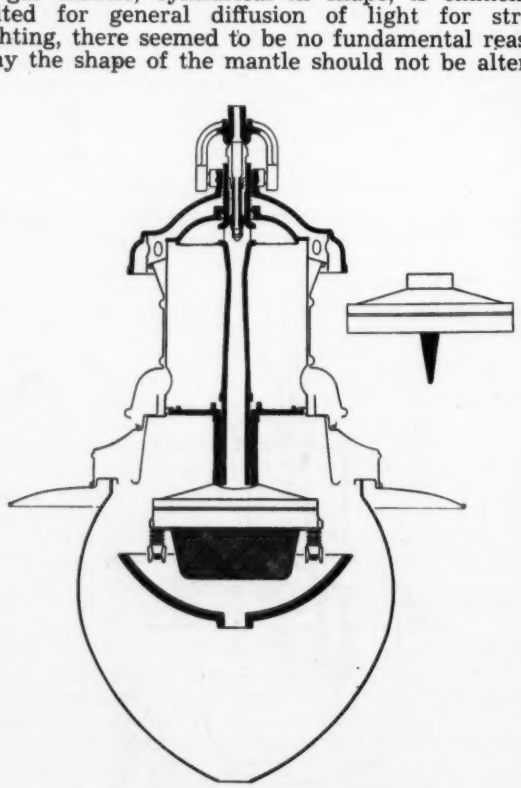

Fig. 10. "Supervia" High Pressure Gas Lamp.

to give the greatest amount of light in the direction of the street. A high pressure gas burner was modified by making the burner nozzle in the form of a slot instead of in the form of a round hole, and a special gas mantle was made consisting of a bag with two flat rectangular sides of greater length than

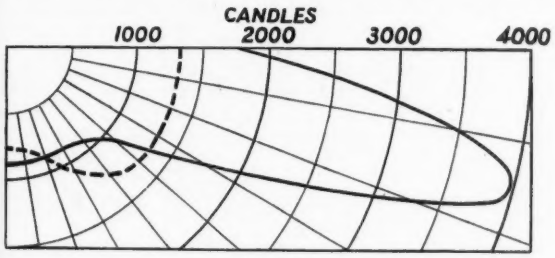

Fig. 11.

depth. A complete lamp of this design is shown in section in Fig 10, and the intensity distribution curves of such a lamp and a non-directional lamp are given in Fig. 11.

It has always been one of the advantages of low-pressure gas lighting that the light may be dimmed at will, but hitherto, with high-pressure gas lighting, some difficulty has been encountered because of the tendency of the flame to contract within and away from the mantle; but with the bag-shape mantle it is possible to reduce the pressure at the nozzle from 81 in. to 30 in. w.g. when the flame still burns in contact with the mantle fabric, giving about half the amount of light obtained at full pressure and consuming about half the quantity of gas. This valuable property makes it possible to provide, at the same installation cost, increased illumination at the hours of greatest traffic, and then, during the later hours of the night, to provide illumination, which, although reduced, is amply sufficient in these circumstances and in excess of that customary during these hours.

The shape of the mantle and the gas burner nozzle are important factors in relation to the amount of light obtained and its distribution, and the author has often considered the possibility of some modification to the usual shape of low-pressure incandescence mantle, which would give some increase in the efficiency of the lamp.

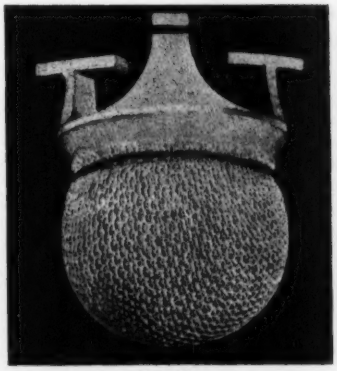

Fig. 12.

Dr. Killing, some few years ago, investigated this point, and his work led him to the conclusion that much was possible in this regard. He found that a mantle shaped as shown in Fig. 12, in conjunction with a nozzle, the lower extremity of which extended to a point near to the bottom of the mantle, gave a considerable increase in the amount of light for a given quantity of gas.

Dr. Killing's important discovery does not appear to have had the attention it deserved.

The author has recently investigated Dr. Killing's views, and a mantle and burner made in accordance with his suggestion gave the interesting distribution shown in Fig. 13. For comparison the results obtained with an ordinary burner and mantle, consuming gas at the same rate and pressure, are graphed in this figure. Burners are now being designed to take advantage of this valuable improvement.

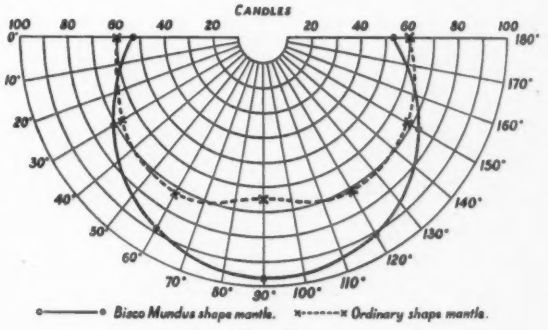

Fig. 13.

Effects of Preheating.

As already stated, recuperation as applied to inverted incandescence gas burners is of very considerable importance. To assess its value an investigation was carried out in the Physical Laboratory of the South Metropolitan Gas Company to determine its effect as influencing the lighting efficiency of the inverted incandescence burner. The results of the investigation have been summarised in a communication to the Society of Chemical Industry*. The experimental investigation consisted of the use of a special inverted gas burner which could be supplied with coal gas and primary air, so that the proportion of primary air to coal gas corresponded with that necessary to secure a well-defined inner cone, such as is produced when the primary air supply is induced by the gas injector. For this purpose the usual air holes of the burner were enclosed completely within a chamber to which a supply of air under adjusted pressure was led through tubes entering the chamber at diametrically opposite points. The pressures of the gas and air supplies were suitably

* J. S. G. Thomas, J.S.C.I., pp. 168—171.T. 38.

governed, and the volumes supplied to the burner were determined by meters.

A determination of the candlepower of the burner at successive angles of 10° below the horizontal was made. Arrangements were then made whereby the mixture of gas and primary air could be cooled right up to the point at which the gaseous mixture was burnt. For this purpose a stream of water was maintained within the cylindrical jacket surrounding the injector, and likewise through a cylindrical jacket of annular section extending to the lowest part of the burner nozzle. In this manner it was found that the radial distribution of luminosity could be readily determined with the incoming mixture maintained cool up to the point of combustion. For purposes of comparison, a series of experiments was carried out with an upright incandescence burner, the primary air supply to which could be preheated to any desired temperature. The primary air was supplied under regulated pressure through a tube coiled within a small gas furnace whereby the coil could be considerably raised in temperature. The results of the experiments, which are graphed in Figs. 14 and 15, indicate that an increased lighting efficiency is obtained when the gaseous mixture of coal gas and primary air is preheated. Whether such preheating is achieved by a separate heating device, as in the case of the experiments with the upright burner, or by the flow of gaseous products of combustion over the incoming supply, as in the case of of the inverted burner, the same result is obtained.

The advantage obtained by applying recuperation to the incandescence gas burner does not appear to have been either fully investigated or exploited.

Some unpublished results of experiments made in the Physical Laboratory of the South Metropolitan Gas Company to determine the effect of preheating the secondary air supplied to a low-pressure incandescent mantle show that an appreciable increase in luminous efficiency is so obtained. The secondary air was metered and passed through a heated glass tube and thence into a specially constructed glass globe which surrounded the incandescent mantle. The diagram in Fig. 16 shows the arrangement of the apparatus, and the curve in Fig. 17 the results obtained. It is to be noted that an increase of 20 per cent. in the luminous output is obtained when the temperature of the secondary air is raised to approximately 480° C. Possible developments incorporating this principle are shown in Fig. 18.

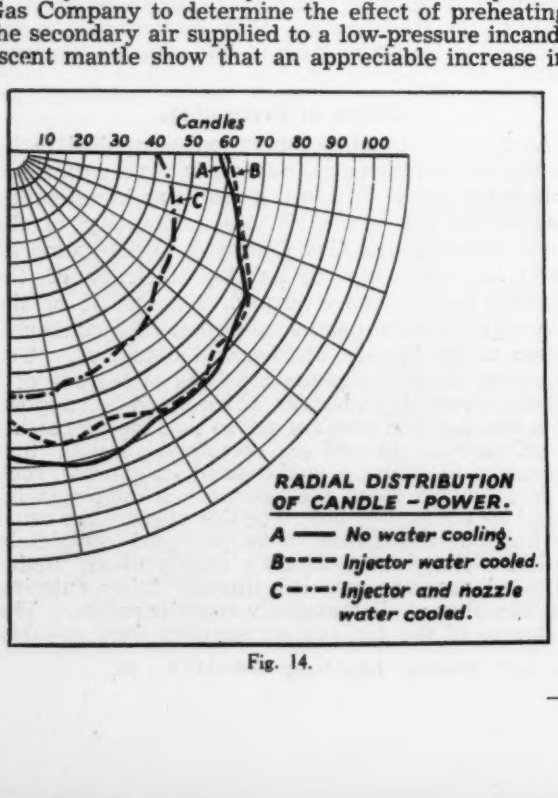

Fig. 14.

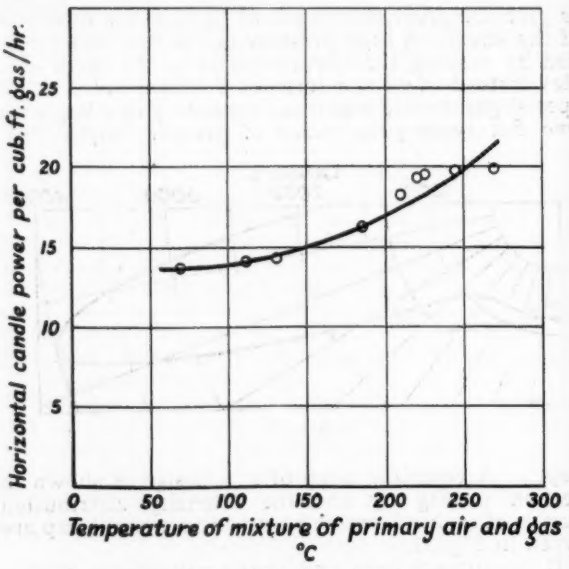

Fig. 15.

Fixed and Adjustable Burners.

In general, incandescence gas lighting burners may be placed in two distinct categories: (1) gas burners designed to function with gases of different and possibly varying qualities; (2) burners designed to function with gas of constant physical and chemical properties. Gas burners of the former class are provided with devices, the operation of which enables one to proportion the primary air entrained by the gas jet.

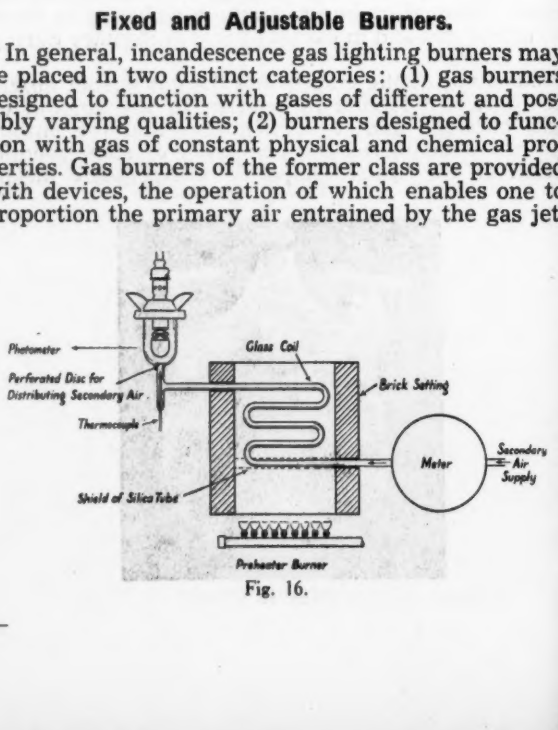

Fig. 16.

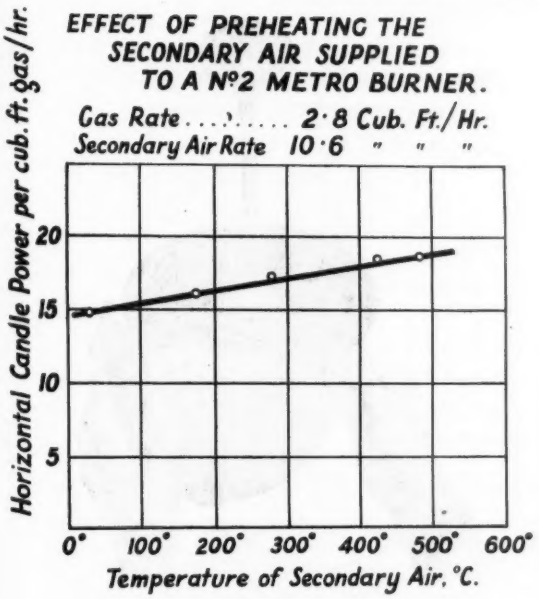

Fig. 17.

The gas rate itself may be set by a needle adjuster. The operation of these adjusting devices is simple. It must not be supposed that the need for adjustment is frequent. A well-designed and properly made incandescence gas burner is reasonably flexible and will function satisfactorily with a fairly considerable range in gas quality.

Where the gas supplied to incandescence burners is standard as to its quality, the use of adjusting devices is unnecessary. The orifice or orifices through which the jet of gas issues may be "fixed" so that only a specified and predetermined volume of gas can pass to the mantle. Likewise, the air ports are "fixed" to allow only the correct volume of air to be entrained by the jet of gas to give the required character of flame on combustion.

With the latter type of inverted incandescence gas burner objection is sometimes made to the slight hiss produced by the issuing jet of gas from the ejector orifice. It is now possible to overcome this by means of a pressure damping device fixed immediately above the fixed proportioned orifice.

Effects of Convection.

With most artificial sources of light the proportion of the total energy supplied to the source which is converted into light is very small. This is true both of gas and electric lamps. The balance, which appears as heat, sets up useful air movement, and if the air is dust-laden some of the dust may be deposited on the ceiling. Darkening is not, as is so often supposed, the result of incompletely burnt gas, even with self-luminous gas flames. One has only to consider the darkened walls above hot water pipes to see that the explanation is the same in the two cases.

During a recent visit to a city in the North the

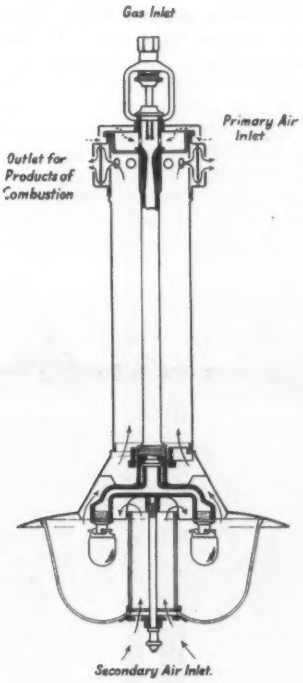

Fig. 18.

author's attention was directed to the condition of the ceiling of the Council Chamber of the Civic Offices. The photograph (Fig. 19) shows the result of the dirt-laden atmosphere upon the ceiling.

The deposit is caused by ascending currents of warm air carrying atmospheric dust which is deposited on cold objects above the source of the heat. To demonstrate this, two cabinets were fitted with

Fig. 19.

upright incandescence gas burners. The two cabinets were identical, except that one of them was fitted with a filtering device at the bottom, for the purpose of filtering out particles of dust and dirt contained in the air entering the cabinet. In the case of the other cabinet, unfiltered air was supplied.

The photograph (Fig. 20) shows the condition of the respective ceilings after a long interval of time. It is clearly seen that the ceiling, in the case of the cabinet supplied with filtered air, is clean. Discolouration of any surface disposed above a source of light

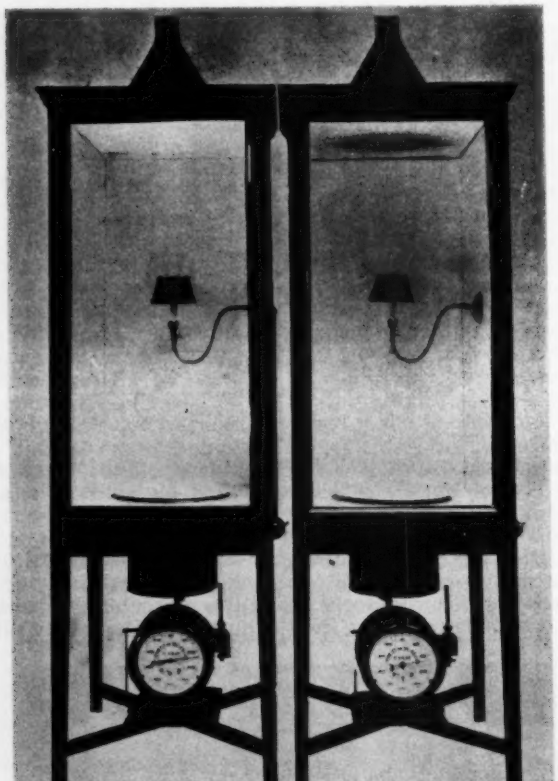

Fig. 20.

which gives rise to warm air currents must of necessity produce some staining, provided that dust is present in the air.

It follows from the experiment that in order to avoid deposition of dust particles by lamps operating in dirt-laden atmospheres it is necessary to disperse the hot products of combustion. In this way the temperature difference between the rising air current and its surroundings is reduced and a consequent diminution in the velocity and dust-carrying power of the rising current is effected.

Fig. 21 is a photograph of a lamp of simple design employing this principle. The method of attachment of the bowl to the dispersing disc by means of a ring

Fig. 21.

with three hooks, one of which is hinged, is clearly seen. A diagram indicating the direction and temperature of the air currents in this lamp and an ordinary lamp of similar design is seen in Fig. 22.

Measurements of the concentration of carbon dioxide in the atmosphere close to the fittings indicate that the volume of air circulating through the dispersive-type lamp is approximately 2½ times that circulating through the ordinary lamp. The graphs in Fig. 23 show the excess temperature attained by a fine thermocouple when placed in the rising currents from the two lamps under discussion, at heights of 3 in. and 12 in. above the rim of the bowl and at various distances from the pendant. The marked difference in the temperature excess of the current at the lower level is obvious, and it is evident that at 12 in. above the rim, except for the region encompassed by a circle of 1½ in. from the pendant, the excess temperature in the case of the dispersive lamp is only about 1-3rd of that prevailing with the ordinary lamp.

How successfully this lamp achieves its purpose is illustrated in Figs. 24 and 25, which are photographs of ceiling boards fitted above an ordinary

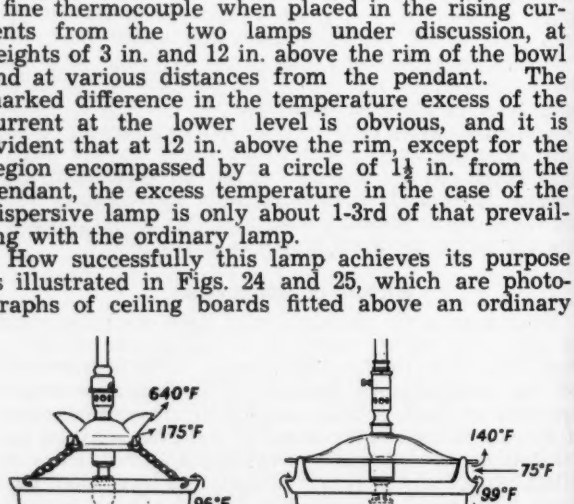

Fig. 22.

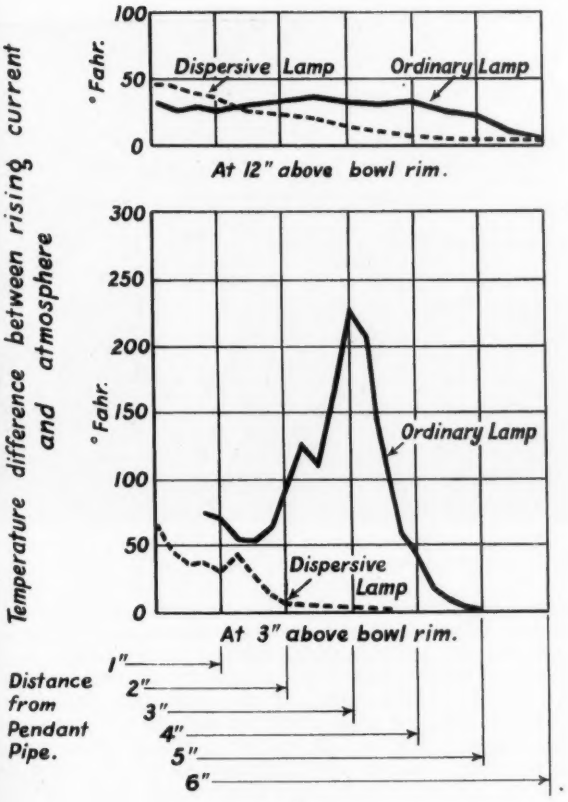

Fig. 23.

and a dispersive-type lamp respectively. These lamps and boards had been set up side by side in a dusty atmosphere, with the distance of the lamp from the ceiling board, the gas rate and the period of burning identical for both lamps.

Heating Effects.

Gas burners not only give light, they give warmth, and for this reason they are often lighted before they are needed for the purpose of illumination in order to take the chill off the room. Gas lamps are sometimes used during the hours of daylight in workrooms to warm and to ventilate the space. Most useful in winter, the warmth from the burner is said to be undesirable in summer. Nowadays, however, most people obtain ample ventilation by open windows and doors. This criticism, therefore, which might have been valid in earlier times, when it was the fashion to be more closely shut in after dark, loses much of its point. In any case the lighting hours in summer are few. Gas burners aid ventilation and change of air.

An interesting application of gas lighting in a factory is the employment in conjunction with it of a special duct system, to serve the threefold purpose

PHOTOGRAPHS OF CEILINGS.

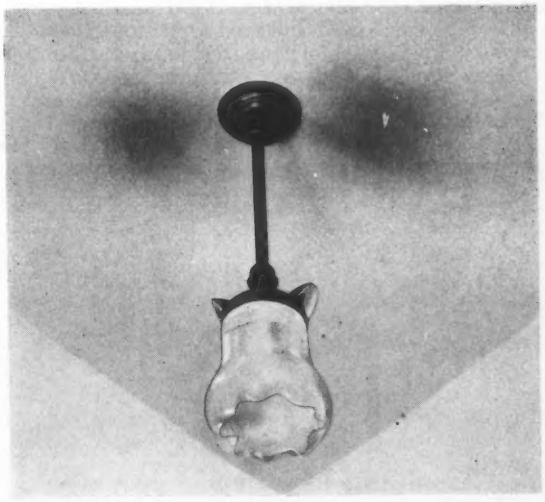

Fig. 24.

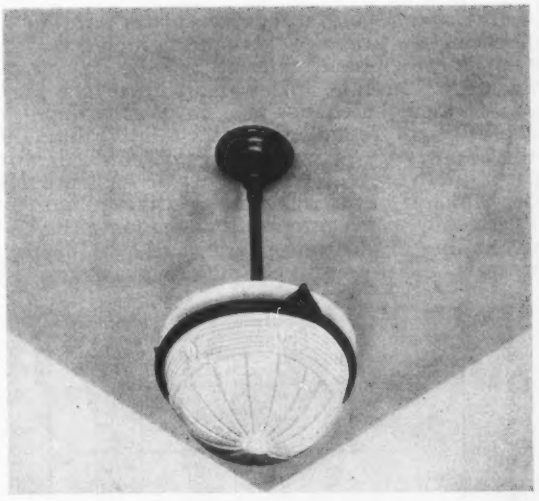

Fig. 25.

of providing light, ventilation, and warmth for the premises.

In a musical instrument factory trouble was experienced due to the high humidity which frequently prevailed. The system of gas lighting mentioned was installed, and the warmth and positive ventilation which it effected lowered the humidity of the factory to a satisfactory degree, and at the same time excellent illumination was provided. A photograph of the installation is shown in Fig. 26, and the effectiveness of the system is well illustrated by the

Fig. 26.

curves in Fig. 27, in which the relative humidity of the factory is shown with two systems of lighting in operation.

The following photographs, Figs. 28 and 29, show typical examples of incandescence gas lighting for engineering workshops. It should be noted that the gas lamps contributed materially to the warming of the factory. In fact, this was an important factor which decided the change-over to gas lighting.

The effect of reduction of the relative humidity of the atmosphere surrounding a lighted gas lamp is perhaps most obvious when a fog or mist prevails, under which circumstances the relative humidity is 100 per cent. In the proximity of the lamp the relative humidity of the atmosphere is lowered, evaporation from the fog particles takes place and the

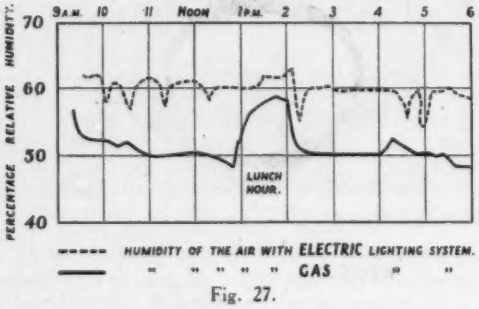

Fig. 27.

Fig. 28.

density of the fog is thereby reduced. Particularly is this effect apparent in large gas lighted factories where light absorption by mist is appreciable due to the long distance over which good visibility is necessary. This advantage of gas lighting is highly appreciated at a well-known South-East London indoor sports centre. At this club the bowling green and cricket pitches are illuminated by specially designed lamps, which give shadowless and uniform illumination over the whole of the surface. For twelve months an alternative method of lighting was tried, but gas was finally chosen owing to the softness of the light and the warmth which accompanied it. The colour of the light contributed to the pleasing tone of the artificial lawn, and the players, many

Fig. 29.

well advanced in years, expressed their pleasure at the sense of comfort to the eyes due to the quality of the light.

Remote Control and Ignition.

The present age in which convenience is everything has aptly been described as the "switching age." By the turn of a knob or the press of a button our world is started or stopped.

It has been contended that the gas light is out of date and inconvenient on the ground that it is troublesome to light and extinguish. This is a fallacy, for "to switch on the gas" is as simple nowadays as to switch on any other contrivance in home, workshop or factory, and there is the advantage that the light can be dimmed to any required degree by the operation of the modern type of control.

In 1929 a new type of gas switch, called the "Positive Distance Control," was introduced. This consists of a gas cock operated by means of a Bowden wire attached to a switch device of neat and simple design. A few years later the electro-catalytic ignition system for use with these valves was introduced and thereby the small by-pass flame necessary with the earlier type of switch was eliminated. This switch employs a platinum alloy filament fixed in a small cup which is held near the mantle. On switching on the gas a momentary contact is made in the switch, thus completing the circuit from a small 3-volt dry battery to the filament. The heating of the filament, due to the catalytic action which occurs when the gas-air mixture streams over the filament, is greatly accelerated by the initial slight electrical heating, and, as a consequence, the filament almost instantaneously becomes white hot and ignition of the gas takes place. The momentary current in the filament is approximately 0.4 amp. and the average useful life of the battery is more than a year. The neatness of these installations and the advantage of dimming which they possess have made them a popular adjunct to the modern incandescence gas burner.

The photograph, Fig. 30, shows a modern kitchenette illuminated by a lamp of the dispersive type described earlier in this paper and to which is fitted an electro-catalytic switch. The switch and battery are fitted behind the metal plate seen on the wall at the side of the door, and the actuating and electrical wires are completely concealed, up to the pendant, in the walls and ceiling.

When a number of gas lamps are required to be lighted or extinguished at the same time, a special device is available, which can be applied to each lamp. It is a simple mechanism consisting of a small chamber containing a valve attached to a flexible diaphragm (Fig. 31).

The diaphragm is moved by the pressure of the gas, so that when the main gas control tap, situated in any convenient position, is turned on, the pressure of the gas in the supply pipe raises the diaphragm and lifts the gas valve off its seating, thereby opening the gas-way to each lamp fitted with this simple device. Again, a by-pass is used for lighting the main burner.

In concluding, mention of the trend of modern developments of gas lighting is, perhaps, appropriate.

The design of catalytic ignition devices for use with automatic controls has now reached a stage at which their performance under the difficult conditions met in public lighting practice is highly satisfactory. The consequent elimination of the permanent by-pass will undoubtedly result in a considerable extension of its use for this purpose and others in which severe conditions exist.

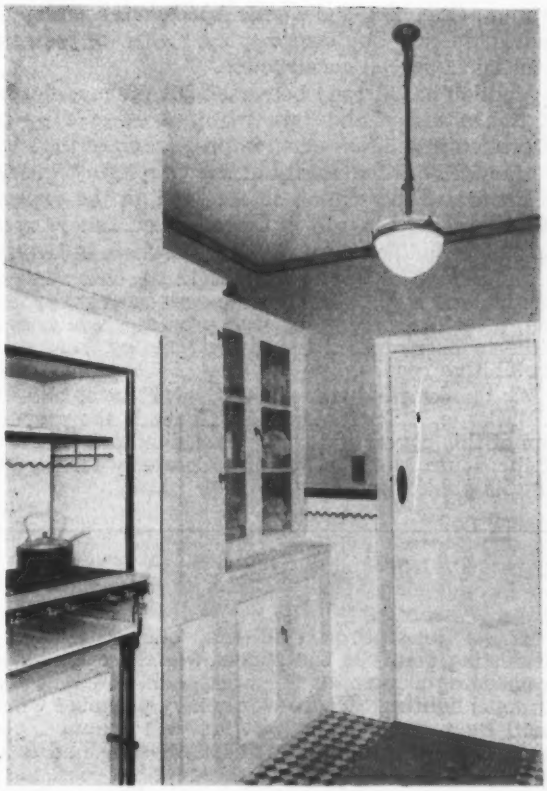

Fig. 30.

Much attention is being directed to the production of mantle fabrics with qualities which will facilitate the use of the incandescence mantle in what are now considered unconventional circumstances. The illus-

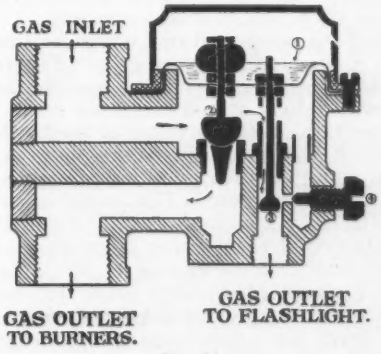

Fig. 31.

tration (Fig. 32) shows the spectacular effect obtained in an outdoor display, with unprotected mantles of special construction.

Mention has already been made of the modification of the nature of the light which is effected by the alteration in the rare-earth impregnation of the mantle fabric. The availability of the "daylight" quality of artificial illumination so obtained, at the expense of only a small loss in illuminating efficiency, opens up a large field of application of this form of lighting in the industrial world. This lighting, cheap in production and installation, is abundant in quantity, and can, therefore, be employed in processes which have hitherto been denied its advantages by reason of prohibitive cost.

My thanks are due to Dr. J. S. G. Thomas and Mr. J. B. Carne, B.Sc., for their assistance in the preparation of this paper, and to the President and Directors of the South Metropolitan Gas Company for permitting its publication.

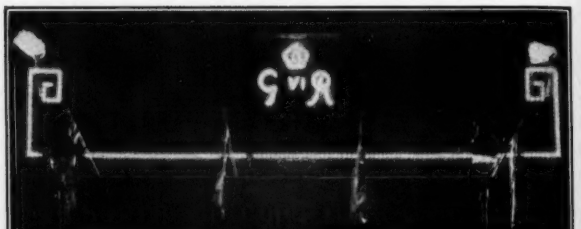

Fig. 32.

DISCUSSION

Mr. A. CUNNINGTON said that one of the most interesting points in the papers was the application, in warming a room, of the waste heat in connection with gas lighting. There were many premises which could be suitably dealt with in that manner, particularly those in which artificial lighting had to be used for the greater part of the day. In these cases it might be a positive advantage to have available the waste heat of the burners which could be utilised in some of the ingenious ways mentioned by the author. He wished he had known of the trough system some years ago, when he had a rather curious problem to deal with in premises where there was condensation trouble due to excess moisture. The extra heat from the radiation surface of the troughs would have obviated that trouble.

It would be interesting to hear whether the author thought there was likely to be any radical departure with regard to mantle construction, i.e., any fundamental difference, such as would lead to a substantial advance in efficiency. Some of the researches which had been carried out recently seemed to indicate possibilities of progress in this respect.

An important point, and one which he had stressed many times, was maintenance costs. Figures for the cost of gas lighting might need modification if full account was taken of maintenance costs — at all events in certain cases. In some of the factory installations which had been illustrated there were probably ideal conditions for good maintenance, but that was not always the case. The importance of maintenance was fully appreciated by the gas companies, who maintained street lighting installations in a most efficient manner. Nevertheless, it would be interesting to have some information with regard to maintenance costs of large installations, which were, as he knew from his experience on the railway, frequently a considerable item.

The paper referred to a type of burner with fixed adjustment for admission of gas and air. This was a simplication likely to aid in overcoming some maintenance difficulties, but was this type of burner entirely satisfactory in the presence of large variations in gas pressure, such as might occur occasionally?

An important development in gas lighting was the high-power low-power pressure lamp, which was described at the Folkestone Conference of the Association of Public Lighting Engineers. He thought there might be a wide field for a lamp of this type, which gained much in efficiency without involving the complication of the high-pressure system.

In the opening paragraph of the paper the author had stated that light was essentially thermal in origin. That might be true in regard to the majority of light sources, but it could hardly be said to apply to recent developments based on the luminescence of gases.

Mr. F. C. SMITH paid a tribute to the work which Mr. Chandler and his company had done for gas lighting and illuminating engineering in general, and said that both the gas and electrical industries suffered from the fact that inferior appliances were often offered for sale by cheap stores which tend to bring discredit upon the two industries by reason of the poor performance of these cheap articles. If the public was to be given the benefit of well-designed lighting appliances at cheap cost, it was necessary to simplify design and to ensure reproduction on mass production lines. That policy had been carried to a high degree of perfection in the "Metro" burner—if he might mention the name, because it was not a trade name in the ordinary sense of the word.

Continuing, Mr. Smith said that he had hoped the author would have said something about the physics of the bunsen burner. The physics of gas lighting is

as interesting and as complex as the physics of any other lighting source. It was within his knowledge that the South Metropolitan Gas Company had done a great deal of work in this connection, and he was somewhat disappointed to find that Mr. Chandler had not mentioned this work in his paper.

There was a further point about gas lighting which was not always appreciated. Within defined limits the light output from a burner is proportional to the B.Th.U. rate. For a given calorific value of gas this is equivalent to saying that light output is proportionate to the volume of gas burnt per hour. A great deal has been said from time to time about the effect of changes in pressure upon light output. It was well to remember in this connection that the volume of gas discharged from an orifice varies as the root of pressure. On the other hand, the light output from an electric filament lamp varies with something like the fourth power of the voltage change. It is, therefore, necessary to preserve a sense of proportion in regard to the importance to be attached to changes in the pressure upon the light output from gas sources. At the same time a pressure governor can be fitted to a large installation at a cost of only a few shillings, and this is a simple way of dealing with the difficulty that Mr. Cunnington had mentioned, when the pressure variations are at all serious.

Another point was that with efficient maintenance it was possible to secure a very constant light output with gas lighting. His own company, for example, was willing to undertake to maintain street lighting within 20 to 25 per cent. of the initial value. This was an important matter having regard to the very keen competition for street lighting. Experience had shown that these values can be maintained in practice.

A matter not mentioned in the paper was that catalytic ignition was being successfully applied to gas, and in the near future he looked forward, with confidence, to seeing this method applied to lighting.

Speaking of flood-lighting, Mr. Smith said he had been interested at the recent meeting of the Decorative Lighting Section to hear mentioned that engineers were looking for a trough source of light which would give a good vertical throw of light when placed at small distances from the face of the building. He had been immensely interested, when visiting the works concerned in the production of the particular type of mantle shown at Folkestone, to see that this works had designed a trough reflector for use with the special mantles which secured a good vertical throw under these conditions. The arrangement was extraordinarily cheap, and he hoped that this type of equipment would be developed. The initial cost of such equipment did not approach that of the expensive flood-lights customarily used. These fittings could be put within two or three feet of the actual face of the building.

If this equipment had been available some time ago when he had a problem put to him for flood-lighting an important thoroughfare in the centre of London he could have gone forward with that scheme with a good deal more confidence than he was able to at the time.

Mr. W. F. THORNE asked the author what he considered the maximum permissible variation in the A.G.B. number or the O.T.T. number, compatible with the smallest variation in candle-power.

Mr. K. F. SAWYER called attention to the statement in the paper that "The reason for the effect of the small proportion of ceria is not fully understood" and asked whether Mr. Chandler was familiar with Rubens' theory, which was given some years ago. Rubens carried out a number of very careful experiments and came to the conclusion that thoria by itself was a very poor radiator. Its emissivity, as measured by Rubens under the conditions he was using, was about 0.03 and the mantle could be raised to a very high temperature because the heat lost by radiation was very small. Ceria, on the other hand, was a comparatively good radiator, and Rubens measured its emissivity as about 0.2. When a small amount of ceria was applied to the pure thoria mantle it was raised to about the same temperature as the thoria alone, but at that temperature the mantle now radiated a considerable amount of energy in the visible spectrum because of the radiating power of ceria. Then, as more ceria was added to the mantle, its emissivity was increased, and consequently more light was obtained. But at each addition of ceria, however, the mantle began to lose energy at a greater rate and the temperature began to fall. There was, therefore, quite a clear maximum concentration of ceria which would give the optimum amount of light without lowering the temperature of the mantle seriously, and that proportion was given as roughly 1 per cent. ceria and 99 per cent. thoria. The emissivity of thoria, however, was not precisely understood, nor was that of ceria. Thoria particularly varied in emissivity according to the nature of its surrounding atmosphere. For example, it depended upon whether it was a reducing or an oxidising flame. Roughly speaking, it could be generally assumed that the interpretation given by Rubens was a fairly satisfactory picture of what took place on the surface of the mantle. On the other hand, he saw experiments conducted not long ago in which the experimenter took a heated mantle and lowered it into its own unignited bunsen mixture in the burner tube and the mantle continued to glow by catalytic action. He gave Mr. Chandler these two opposing theories and would like to hear which one he favoured.

Mr. J. S. Dow remarked that little publicity had been given to the daylight gas lamp mentioned by Mr. Chandler. Few of those outside the technical circles of the gas industry knew much about this mantle. The mantle, with its appropriate reflector, should be made familiar to the public as a complete "daylight unit" which had interesting possibilities.

Mr. Dow also asked for further information in regard to one or two of the lamps mentioned in the paper. He believed that in the early days of the Supervia lamp there had been some difficulty with

regard to breakage of mantles. No doubt that difficulty had now been overcome, but could Mr. Chandler state how the mantle maintenance compared with that for lamps using the ordinary spherical mantles? Then there was the question of the performance of lamps in relation to the particular gas supply available locally. Suppose a man bought a lamp in London and used it there. If he removed the lamp to Birmingham, Manchester, or some other city, would he still use that lamp equally well without any serious adjustment being necessary. Or was it necessary to make structural alterations such as required special expert knowledge? It would be useful to know how far this applied to the new lamp shown at Folkestone, which had evidently great possibilities, but seemed to be a little intricate in design and possibly needing some degree of expert attention in order to ensure efficient operation.

Perhaps also some idea might be given of the complete luminous efficiency of the modern gas unit, which might well be lower than the so-called radiant efficiency derived from a study of distribution of energy in the spectrum. In the case of the electric lamp, no doubt practically all the energy supplied at the terminals served to heat the filament. In a gas lamp, however, there must surely be considerable waste in heating up the burner. However perfect the shape of the flame, there must be some loss of heat in the flame which did not exactly fit the mantle. Therefore, it seemed preferable that the overall efficiency was very low. If so, this should serve as an encouragement to the gas industry, seeing that the theoretical margin for improvement provided great scope for further practical progress.

There was one rather cryptic statement in the paper, where it was stated that "in the proximity of the lamp the relative humidity of the atmosphere is lowered, evaporation from the fog particles takes place, and the density of the fog is thereby reduced." He would like to know whether, in Mr. Chandler's opinion, the effect was purely a local one, and took place only, say, one or two feet away from the lamp, or whether it extended to a greater distance. If there was justification for the belief that radiant heat dissipated fog, the idea of beam combining radiant heat and visible light in order to secure good penetration, might not be wholly illusory!

The PRESIDENT, referring to the heat given out by incandescent gas lighting, said that if the mantles were made to give out very much less heat it would make things very much easier for him, because it was a most difficult job to make glass to stand up to the intense heat given off by such a lamp as the "Supervia" or that described at Folkestone by Mr. Keith. Therefore, as a general expression of opinion he would like to suggest to the author the desirability of producing more light and less heat!

With regard to the daylight mantle, Mr. Chandler had said this gave a daylight effect with very little reduction in light. If that were so, then Mr. Chandler had something which nobody had obtained hitherto. In the case of electricity, the loss of light was something like 50 per cent. when anything approaching a daylight effect was obtained, and in the case of true daylight effect the loss was as much as 75 per cent. Therefore, it would be interesting to know how near a resemblance to daylight was achieved by this mantle, and how big was the small loss of light referred to. Moreover, did these mantles keep their daylight colour throughout their life, or did the colour gradually fade away as the mantles got older?

In dealing with the firing of furnaces, heating engineers had found it possible to superheat the gas and air to a high degree. Could Mr. Chandler say whether there was any possibility of that happening with gas when burned for illuminating purposes, or had the maximum degree of superheating practicable been already attained?

Mr. CHANDLER, replying to the discussion, and dealing first with Mr. Cunnington's question as to the possibility of radical improvements being made in the design of mantles, said he could only answer by pointing out that the matter of designing mantles of higher efficiency was continually before the gas industry. As regards maintenance, nobody knew better than Mr. Cunnington that this depended on a number of factors, and it was quite difficult to specify any particular figure with regard to maintenance. In South London the street lighting installations were maintained by a specially trained staff, and the cost of maintenance in relation to the total cost of lighting was extremely small. It might interest Mr. Cunnington to know that during the last twelve months at least a dozen large factories in South London had adopted gas lighting as a result of their investigations into upkeep and general suitability. The question asked by Mr. Cunnington with regard to the effect of variations of pressure on lighting units had been answered by Mr. Smith. In South London the variation in gas pressure was not considerable—in fact, it was quite small—and where the district was properly governed by local governor systems troubles from the cause mentioned were almost negligible. If a properly designed burner was standardised to work with three inches water column, and this was increased at times to four or five inches, it merely meant that the jet entrained a greater proportion of air and, provided the burner was properly designed, the result was that the extra amount of gas passed, developed a higher flame temperature, due to the greater air, and the amount of light given from the mantle was proportionately increased. With a considerable increase in pressure there might be trouble from noise, but that might possibly be overcome. A lighting unit could be set to the local conditions where there were means of adjustment, and in the case of the non-adjusting burner it could be done by means of the gas tap. This indicated about the extent of the difficulty; in South London there were about 1½ million incandescent inverted gas mantles working on a fixed gas and air proportion, and, generally speaking, they were giving full satisfaction. Moreover, the pressure in South London varied only a small extent from what the conditions would be in a factory.

With regard to Mr. Cunnington's comment on the statement in the paper, that light was essentially

thermal in origin, Mr. Chandler said he put that statement in because he wanted to hear other views on it. He knew that physicists and electrical engineers did not all agree with this view; it was an interesting point, and he would leave it for others more capable than himself to debate.

As to Mr. Smith's disappointment that the paper did not deal with the physics of this subject, he could only suggest that there was no more competent person than Mr. Smith himself to write a paper from this point of view. The Council might bear that in mind. Reference was also made by Mr. Smith to the cold catalyst, but he himself had purposely refrained from saying anything about that. He was familiar with the work being done at Watson House and was greatly impressed by it, but at the moment, in his judgment, the cold catalyst was not out of the wood. It had a long way to go before it could be regarded as a satisfactory and reliable device for gas lighting. If, however, the work being done at Watson House resulted in the cold catalyst being used for the purpose of igniting gases under all circumstances, then the electrical people would have to look to their laurels. One of the difficulties to be faced was that the ignition by gas passing through a by-pass or small slot was not the most desirable method.

With regard to the question asked by Mr. Thorne with regard to the Ott number, Mr. Chandler said that, in his view, the Ott number was not at the present moment an invaluable guide in the matter of gas qualities, and therefore he was not in a position to answer that question directly, but later he would state the position more clearly as to how the Ott number could be applied to burners which were available to-day.

Replying to Mr. Sawyer, he said he knew something of the theories mentioned, and all he could say was that he was inclined to the view held by Professor Vivian Lewes, and subsequently by Smithells and Dixon, viz., that the light given from an incandescent mantle which was impregnated with thoria and ceria in the proportions of 99 per cent. and 1 per cent. was due to catalytic action. Rubens's theory was a pretty one, but it had been severely criticised by Smithells and Dixon. Personally, he felt it difficult to say which was the right theory and he left it at that.

As to the suggestion by Mr. Dow that the gas industry was hiding its light under a bushel in the case of the daylight gas lamp, that had always been a feature of the gas industry! It was far too modest, and in this case Mr. Dow was right. The daylight gas mantle had been in existence for a long time and wherever it had been used for colour matching it had given great satisfaction. Steps would have to be taken to see that the lamp was brought more prominently to the notice of the public.

With regard to the Supervia lamp and mantle troubles: of course, this lamp went through its teething troubles and in the early days the life of the mantles was shorter than the life of ordinary mantles, but the reverse was now the case, the records showing a life longer by from 20 to 25 per cent.

On the question of whether burners originally used in South London could be used in Birmingham, Manchester, or elsewhere without serious re-adjustment, the answer was that burner makers provided adjusting devices and that, generally speaking, the burner was sufficiently flexible to accommodate any gas in any part of the country.

In reply to Mr. Dow's question concerning efficiency—presumably he meant the thermal efficiency—taking the low-pressure incandescent gas mantle, approximately 0.2 per cent. of the total heat supplied to the burner was converted into light. That was a small amount, but in the case of the gas-filled coiled coil electric incandescent lamp the quantity was only 1.85 per cent. In the case of the high-pressure gas lamp the figure was higher than for the low-pressure gas lamp. However, well over 99 per cent. of the total energy supplied to the gas lamp was converted into heat, and that was where the gas lamp scored because that heat could be made use of for warming buildings. The poor people who used gas appreciated this, and he had been repeatedly told that they welcomed the incandescent burner in their rooms—and particularly in bedrooms—because of the warmth they obtained from it.

The point raised by the President as to the difficulty of getting glassware to stand up to the heat of the gas lamp was a matter for research among the glass makers. In most of the factory installations to which he had referred, no glass was used with the lanterns, and, of course, this affected the cost of maintenance because there was no glass to clean. It was, however, a surprise to him to hear that glass got " red hot," as the President had said.

The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.

With a view to avoiding possible confusion with other publications, reference to these Transactions should be in the form:—"Trans. Illum. Eng. Soc. (London)."

Printed by the Argus Press, Ltd., Temple-avenue and Tudor-street, London, E.C.4, England.